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ABSTRACT

The paper examines implications of the application of computer expert systems in the field of education, particularly special education. The development of expert systems in general is reviewed as are its applications in education as intelligent tutoring systems and in special education in the areas of student classification, teacher education, math teaching consultancy, and language teaching consultancy. The literature on the role of artificial intelligence is then reviewed noting concerns with increasing reliance on technology, the increasing tendency toward technological elitism, possible reductions in human creativity, and the need for man to control technology and not be controlled by it. While noting the contributions of computer managed learning to special education in individualizing learning and recordkeeping, the paper raises questions concerning effects of future more extensive use of artificial intelligence in the teaching and learning process. (DB)

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THE DARK SIDE OF CML: A LOOK AT EXPERT SYSTEMS

A PAPER PREPARED FOR:

THE 68th ANNUAL CONVENTION OF
THE COUNCIL FOR EXCEPTIONAL CHILDREN

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ABSTRACT

This is a brief discussion of computer-managed learning (CML) and the application and implication of computer expert systems as they are applied to the field of education, particularly special education. The application of expert systems in education broadens the scope of CML and impacts what it means to be a teacher. With the addition of machine intelligence, cautions associated with the use of conventional CML are magnified. The purpose of this paper, however, is to stimulate further discussion and should be considered only as introductory remarks.

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... we may become no longer free for the kind of thinking that would redeem us from the world we ourselves have created. We may have made ourselves incapable of such thinking (Barrett, 1979, p.201).

From the late 70's to the mid 80's, a period relatively coinciding with the advent and maturity of the microcomputer, the merits of computer technology were in considerable debate. Many futurists argued that society would undergo significant changes due to technological influences and claimed society was in the throws of a computer revolution (Evans, 1980; Friedrichs & Schaff, 1982). Philosophers struggled with the meaning of technology and warned of the implications associated with a technological "mind set" and challenged the validity of an information economy (Barrett, 1979; Roszak, 1986). More importantly, the computer was no longer the reserve of business, government, and the military - it had entered the home.

Educators, as well, discussed the influence computers would have in schools. There was special interest in computer cultures, and some envisioned a day when a computer would sit on every desk (Papert, 1980; Bork, 1985). However, in an applied field such as education, fads come and go and the staying power of an innovation is measured by its practical application. According to Taylor (1980), computers have made an impact in schools as tutors, tutees, and tools. As tutors, the computer does all or part of the teaching. We more often

refer to this as computer-assisted instruction or computer-assisted learning (CAI,CAL). As tutee, the computer becomes student, and the user teaches the computer. The most celebrated example of this is LOGO. As tool, the computer serves the student or teacher. Through application programs, such as word processors, spreadsheets, or databases, the production of assignments or records is made much more efficient. More sophisticated applications are often associated with computer management of instruction or learning (CMI, CML). It is to this area that we now turn.

We commonly think of CML as record keeping or "the use of technology to collect, analyze, and report information concerning the performance of students in an educational program" (Gorth & Nassif, 1984, p.28); however, more elaborate systems are capable of directing the entire instructional process, including the CAL format (Splittgerber & Stirzaker, 1984; Alessi & Trollip, 1985). More recently, such systems have included a consulting component, or expert system, which can advise the teacher which instructional strategy is most likely to be effective (Hofmeister, 1988). These systems take advantage of one of the leading edges of technological development, artificial intelligence - the attempt to have the computer mimic human decision making (Colantonio, 1989).

Many practical applications of artificial intelligence have been very recent, and are not in areas where the general

population is usually privy; however, expert systems are advancing rapidly and being applied in government and business in an unprecedented way (Richards, 1989). An expert system can be thought of as a computerized "vehicle for collecting, crystallizing, and disseminating expertise in a specific knowledge domain" (Hofmeister, 1988, p. 2). It has three components: an inference engine, a knowledge base, and a memory cache. The user asks or is asked questions which are recorded in the memory cache. The inference engine, usually using a series of IF THEN rules, analyzes the information being accumulated and eventually provides the user with alternatives, often with a certainty factor. For example the system may suggest that the cause of a particular problem is likely X with an 85% certainty. Potentially, expert systems can be employed in any area were a reasonably stable knowledge base exists, where rules have been established to manipulate that knowledge, and where problems have established solutions (Lubke, 1988).

The medical and psychological application of expert systems illustrate a broadening of scope and a willingness to apply artificial intelligence in areas that have traditionally relied heavily on human judgement, areas where an element of subjectivity continues to receive some respect. MYCIN a system designed to diagnose types of bacterial infections and ONCOCIN a system developed to assist doctors administer

chemotherapy are examples of expert systems of considerable power. Their accuracy is considered as good, if not better than the judgements of a human practitioner (Rennels & Shortliffe, 1987; Richards, 1989). Using expert systems to conduct and interpret psychological tests has proven both efficient and effective and been widely applied (Moreland, 1987; Joyce, 1988). Joyce (1988) reports that: (1) computers perform interviews more systematically and often more thoroughly than humans, (2) clients are apt to be more frank and truthful when answering questions generated by a computer, (3) clients often are less nervous around the computer, (4) computers, unlike clinicians, do not express bias through nonverbals, and (5) computers sort and analyze the data very quickly. Computer therapy programs are not as common, but they have been applied in such instances as a therapeutic learning program to help patients clarify problems and resolve conflict, a behavior management program to assist clients to stop smoking, and a counselling simulation program to train couples in domestic problem-solving strategies (Joyce, 1988).

Expert systems are also making inroads into education, where intelligent tutoring systems (ITS) may be considered one of the more advanced applications (Wenger, 1987). Intelligent tutoring requires that the system used is capable, in some manner, to emulate the interactive nature of teaching. This does not mean that there need be an attempt to replace human

teachers, but that intelligent tutoring systems go beyond the notions of CAL and CML. Advances in this area are slow, but the goal is to produce a system that can "compose instructional interactions dynamically" (p.5). This implies that intelligent tutoring emulate the pedagogical expert, the teacher, in that the system is able to produce instruction, answer queries from students, assess the student's current state of knowledge, and adjust instruction to that state of knowledge. Wenger also suggests that these systems may very well have different teaching styles from their human counter:

> ... while computers are weak at improvisation, they tend to outperform people in the precision and completeness of their use of available information (p. 6).

Several systems are designed to tutor, but many are diagnostic and didactic. In other words, they instruct from "domain specific information with a pedagogical perspective" (p.420). However, like other applications of computer technology, intelligent tutoring has been evolutionary. We have progressed from systems such as SCHOLAR (p.31) that conduct tutorial dialogues to systems that reflect a more global view of knowledge communication such as "the QUADRATIC tutor", which, "monitors the validity of its own pedagogical principle, experimenting with possible improvements" (p. 420).

Special education is a complex area and involves diagnosis and remediation of many learning disabilities, and

it has become increasingly more difficult for special educators to keep abreast of recent advances. More significantly, it has been documented that error rates as high as 50% in the identification of learning disabled students has contributed to a large number of student misplacements (Shepard, Smith, & Vojir, 1983; Ysseldyke, 1983). Furthermore, government legislation in the field has made the deliverers of special services publicly accountable for programming (Morgan & Rhode, 1983). As a result, expert systems are apt to be particularly attractive to special educators. Hofmeister (1988) outlines four systems that have been developed at Utah State University, one to help classify the learning disabled (CLASS.LD2), a second to help train prospective special educators to apply classroom knowledge in solving complex field problems, a third to provide advice to teachers concerning math (Effective Math Teaching Consultant), and a fourth to counsel teachers on language (Written Language Consultant). Research continues in these directions in the faith that artificial intelligence applied through expert systems will "positively impact both teacher behavior and student outcomes (p. 5)."

Many educators see the benefits of technology and apply computers in interesting and creative ways, yet when faced with the prospect of having a machine serve as teacher and consultant they experience an uneasiness; however, if

machines, are able to provide quality instruction, and, as well, serve as consultants in educational decision making, must we not set pride aside and acknowledge these benefits and use these systems? Not all would answer yes. Critics of conventional CML caution against an unquestioned reliance on electronic information systems and maintain that there may be too much emphasis on data and not enough emphasis on instruction (Kohl, 1985). The system may control the user and narrow the pedagogical perspective from which the teacher views the educational situation (Bork, 1985). Prescriptive systems, especially those with lock step procedures may circumvent important educational outcomes, such as aesthetics and intuition (Erlwanger, 1973). More importantly, however, is the perception that technology inherently promotes particular outcomes, that technology is somehow only capable of being beneficial (Sheingold, Kane, & Endreweit, 1983).

Although, Minsky (1986) suggests that the brain is nothing more or nothing less than an elaborate machine and that it will only be a matter of time before we create a perfectly accurate and reliable "thinking machine," artificial intelligence has not been without its sceptics. Joseph Weizenbaum (1976), a colleague of Minsky's at MIT, suggests that the computer as brain comparison is logical simply because science has a tendency to look for clues where they are best "illuminated" (p.127). The computer presently is the

best light that we have in which to study the brain; it is the best metaphor if you like. However, much of human thought is difficult if not impossible to describe, making it doubly difficult to emulate. Roszak (1986) further suggests that even the metaphor may be erroneous and suggest that these metaphorical elaborations are "plain bad thinking" (p. 44).

Earlier work in artificial intelligence proved quite promising, but soon bogged down when knowledge engineers found it difficult to extract exactly what it was that made an expert an expert. Dreyfus and Dreyfus (1986) believe artificial intelligence research is presently at a stalemate because researchers are unable to model the apparent intuitive nature of humans. They suggest that there is a fundamental difference between "knowing how" and "knowing that". We can duplicate the latter in acute detail, but it is a different kind of intelligence that allows humans to know how. You might say that humans make decisions often without the benefit of analysis or rules. Dreyfus and Dreyfus argue that it may be some time until we can teach machines to have "perspective" (p. 48).

Nevertheless, technological inroads into major societal institutions, especially those of industry and commerce, are very pronounced. Like most human innovation that has impacted society, technology has been ambivalent. Through advances in science and technology, we have lengthened our lives,

increased our economic productivity, and enhanced our leisure, yet the other side of the coin shows that the same advances have threatened our planet and enslaved us to data. As we rely heavily on technology, we often rely on the problem for the solution. How do we cope with such a paradox? What dangers lurk in the background, as we allow machines to guide the decision making processes associated with education, when we let machines manage learning?

A concern of some sceptics is the increasing reliance on technology and the growing ease with which people often relinquish their personal responsibilities to the machines they use. Weizenbaum (1976) cautions that machines make decisions amorally, and as we rely more on machine intelligence, we too may become less moral. He cites the military as an example, suggesting that it seemingly has become easier and more acceptable to destroy because of the psychological distance that machines provide between decisions and repercussions. Annihilation is represented by a mere "blip" on a monitor thousands of miles away from the target.

Chris Clegg (1989), warns of the increasing tendency toward technological elitism as those responsible for the design of intelligent machines become more confident in their products. As machines become more powerful and more "expert" we are apt to unwisely give the machine and machine designer far more privilege in our lives than we will some day desire.

"Many designers behave as if the humans in systems are sources of error and unpredictability that therefore need automating out" (p 401).

Roszak (1986) indicates that people have equated information with knowledge and thinking with what computers do. We think with ideas not information, and "information does not create ideas; by itself, it does not validate or invalidate them" (p. 88), thinking does. He warns that too much data can crowd out ideas leaving disconnected, sterile, and shapeless facts. Postman (1979), like Roszak, is concerned with information from a qualitative point of view. He suggests that many people just do not have the intellectual abilities to understand the "assumptions of the technical thesis" (p. 100). His fear is that by allowing stewards of information to control information and machines to do our thinking, the very essence of humanity, creativeness, will be reduced. He feels that through creativity man has been able to "conquer loneliness, ignorance, and disorder" (p.135).

William Barrett (1978) believes that "we are always more than any machine we may construct" (p. 93) and would suggest that the computer "only gives back ourselves" (p. 103). In other words the machine is, in many ways, a mirror of our human traits and reflects our characteristics whether they be humble and creative or arrogant and destructive. He continues with the idea that all technique is a product of human

philosophy and consequently no technique ever produces a philosophy (p. 105). We are often trapped by our own creations; however, our creations can not be more than ourselves. He discusses how thoroughly we have "bought into " the Cartesian split and suggests that "dualism is man's self-assertion over nature" (p. 190), which suggests that technology is a product of and serves to support and enhance a philosophical premise of positivism. He would agree with Schumacher (1977, p.56) that a "science of manipulation" may be more valued than a "science of understanding". In some ways, technology is the tail that wags the dog.

As we continue to practice in the field of education, not only do we contend with the conventional issues of computers as teaching and management assistants, but must consider the possibility of computers as administrators and consultants. Special education, with its unique student population, has utilized CML more extensively than other areas of education. The emphasis on individualization and a real need for accurate record keeping has literally forced special educators into investigating the possible laborsaving advantages of implementing a computer-managed learning program. As educators, will we too experience a sense of distancing as we rely on expert systems to recommend solutions for learning problems? Will it be easier to make those morally difficult decisions that affect the lives of our students for years to

come? Will we experience a sense of inferiority as we rely on expert systems to recommend solutions to complex problems? What assurances will we have that the expertise that the machine supposedly models is the expertise we desire? Are we apt to become too lazy to find out? In a "system" where objective accountability is legislated, is there room for intuition? Are we reducing education to behavioral objectives and test scores? Are special educators likely to be susceptible and less critical of a technology promising to relieve the burdens associated with teaching a difficult population?

Some addressed technological determinism, from the perspective that machines are not, determining the psychological or social future of mankind, but rather, contend that computers have provided another way for people to extend their thinking and to think about themselves (Papert, 1980; Sherry Turkle, 1984). However, when we extend these arguments into the realm of artificial intelligence, we should consider that achieving machine intelligence is largely determined by what definition of intelligence is used (Fischler & Firschein, 1987). Since these definitions may range from the measurement of performance objectives to speculation concerning the cognitive mysteries of the mind, it is not likely agreements will soon be forthcoming. However, there appears to be little doubt that man will continue to benefit from technology, but

we must never be trapped by thinking that a "good thing" implies that more of a "good thing" is better. Whether or not we accept a thesis of technological determinism is less important than developing the wisdom needed to use the technology.

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